

REMARKS

Applicants' attorney acknowledges with appreciation, the interview courteously extended by Examiner Nguyen on 4/11/06. During the conversation, applicants' attorney related:

1) That claims as amended better define the preferred embodiment of the present application over the Shabtai '167 reference, in that the lignin is extracted and base-catalyzed depolymerized in water at a low base concentration of about 2-5% by weight, in the absence of alcohol (unlike in Shabtai '167 where the base catalyzed depolymerization requires inclusion of a super critical alcohol, such as methanol and ethanol – to get a conversion to ether solubles of between about 73-74 percent) whereas the present invention obtains conversion to ether solubles between about 73 to about 74.5% using a base concentration of 2 to about 5 weight percent, due to the absence of a supercritical alcohol; and

2) The hydroprocessing step of the preferred embodiment accomplishes simultaneous hydrodeoxygenation and hydrocracking by use of a co-catalyst system of sulfided $\text{MMo}/\gamma\text{-Al}_2\text{O}_3$ for hydrodeoxygenation and a sulfided $\text{MMo}/\text{SiO}_2\text{-Al}_2\text{SO}_3\text{-zeolite}$ for hydrocracking, where M=Group VI-VIII transition metal promoters of Ru, Co, Re, Cr, Fe, Pt and combinations thereof – and that, by contrast, the hydroprocessing step in the '167 patent is done sequentially by first hydrodeoxygenating and then hydrocracking to arrive at an aromatic hydrocarbon comprising C_7 to C_{10} alkylbenzenes and, the preferred embodiment of the present application obtains C_7 to C_{10} alkylbenzenes of a purity greater than 90% for use as a high octane blending component for lower grade petroleum derived gasoline.

Accordingly, the foregoing advantages of the present application are not suggested or taught in the '167 Shabtai patent. The secondary references of Jelks directed to a process of delignification of biomass and Lucas et al. directed to producing ethanol does not cure the deficiencies of Shabtai '167, as Jelks treats the lignin in the process of delignifying with three steps prior to aqueous extraction in an alkaline material – inclusive of using nascent oxygen to treat the fibers prior to the aqueous alkaline treatment, and thus does not depolymerize using alkali with water alone. Neither does Jelks make reference to use of its delignified product for further treatment as a blend for petroleum. Lucas et al.'s treatment of biomass uses counter-current extractors to extract salts, proteins and hemicellulose, obtains lignin and silica from the residue in a second extraction, and separates the lignin from silicate by ultrafiltration and produces ethyl alcohol as a fuel per se. There is no reference to or mention of further treating this lignin after separating ethyl alcohol therefrom.

Consequently, there is no incentive for or reason why one would want to combine Jelks or Lucas et al. with Shabtai et al., in the absence of hindsight after reference to applicants' application. The secondary reference of Shabtai '272 adds nothing over Shabtai '167 in that its base-catalyzed depolymerization reaction must proceed in the presence of a supercritical alcohol – which teaches away from applicants' application. Therefore, the combination of these references fails to render applicant's application as presently recited, obvious. It is therefore believed that the interview has materially advanced the prosecution of this application.

In converting a biomass into a blending component for petroleum-derived fuel in which lignin is extracted in a reaction medium from the biomass to provide a lignin feed material that is depolymerized and subsequently hydroprocessed to provide a blending component for use in petroleum-derived fuel, applicants are the first to use water alone as an inexpensive reaction

medium along with alkali hydroxide in amounts of from about 2 to about 5 weight % in the absence of alcohol to obtain high base-catalyzed depolymerization (BCD) activity and hydroprocessing the BCD in a single step by effecting simultaneous hydrodeoxygenation and hydrocracking using a co-catalyst system of a sulfided $\text{MMo}/\gamma\text{-Al}_2\text{O}_3$ for hydrodeoxygenation and a sulfided $\text{MMo}/\text{SiO}_2\text{-Al}_2\text{SO}_3\text{-zeolite}$, where M=Group VI-VIII transition metal promoters of Ru, Co, Re, Cr, Fe, Pt and combinations thereof, that results in C_7 to C_{10} ether solubles (about 73 to 74.5 weight percent) of a purity greater than 90% by wt.

This is unlike the use of alkali hydroxides in super critical alcohol reaction mediums, such as methanol and ethanol, as disclosed in the primary reference of Shabtai '167.

Claims 1, 4, 7-16, 19, 21, 22, 24, 25, 27-32, 39, 41, 42, 44-48 and 50 were rejected under 35 U.S.C. 103(a) as unpatentable over Shabtai '167 in view of either Jelks or Lucas et al.

Applicants respectfully traverse the rejection and request reconsideration for reasons hereafter expounded.

Shabtai '167 only converts a lignin material into a blending component for petroleum-derived fuel by extracting in a super critical alcohol (col. 7, lines 26-31) prior to hydroprocessing sequentially to produce a blending component. As disclosed in Shabtai et al. '167, at col. 7, lines 14-36, a super critical alcohol such as methanol or ethanol is indispensable to its process.

By contrast, the present process utilizes water as the reaction medium, wherein the alkali hydroxide is dissolved at low concentrations of 2-5 weight percent, yet obtaining about 73 to 74.5% conversion to ether-solubles, to provide a major technoeconomic advantage of markedly increased depolymerizing activity. The different process of Shabtai '167 does not obtain these levels of conversion below 10 weight percent inclusion of alkali hydroxide (see page 10, line 6 – 25 of present specification). As such, applicants' process and the results therefrom are patentably

different from Shabtai et al. '167 in which alkali hydroxide together with supercritical alcohols depolymerizes, but only comparably at high concentrations of alkali hydroxide equal or greater than 10 weight percent.

Although Shabtai et al. '167 uses alkali hydroxides in alcohol-water mixtures (column 7, lines 37-53), no where does Shabtai '167 suggest or teach the use of water alone with alkali – let alone at 2-5 weight percent.

This deficiency of Shabtai et al. '167 is not taught in any teachings in Jelks or Lucas et al. Jelks only discloses a process for delignification of cellulosic biomass comprising:

- (a) providing a defiberized, lignin-containing biomass of cellulosic material;
- (b) reducing the biomass to a fiber slurry of lignin-containing cellulosic material;
- (c) modifying the lignin in the fiber slurry by a step comprising in situ formation of nascent oxygen, not occurring as a result of hydrogen peroxide decomposition, in the fiber slurry; and

- (d) extracting at least a portion of the lignin from the fiber slurry by washing the fiber slurry with an aqueous solution of an alkaline material.

Thus, Jelks lacks depolymerizing using alkali with water alone, and there is no reference to or mention of, the suitability of its final product as a blend in petroleum based fuel.

Lucas et al. disclose a process for producing ethyl alcohol, but makes no reference to use of same as a blend in petroleum-based fuels). Lucas et al.'s process entails a continuous treatment of plant biomass using state-of-the-art counter-current extractors to extract salts, proteins and hemicellulose (first extractor); obtaining lignin and silica from the residue coming from the first extractor (second extractor); separating the lignin from the silicate using an ultrafiltration unit, in plants containing a high percentage of silica; producing ethyl alcohol

(ethanol) from the cellulose coming from the second extractor; and producing a mixture of lignin and ethyl alcohol (ethanol) as a high energy fuel.

Consequently, only a mixture of lignin and ethanol is produced – and no aromatic hydrocarbon comprising C₇-C₁₀ alkylbenzenes useful as a blend to enhance the octane rating of petroleum derived fuel is obtained.

Accordingly, even if the methods of obtaining and treating lignin from Jelks or Lucas et al. were substituted for the lignin modification process of Shabtai et al. '167, applicants' application using a dilute solution of a base in amounts of 2 to 5 weight percent in water as the reaction medium would not result.

Claims 17, 18 and 20 have been rejected as being unpatentable over the references as applied to claim 1, further in view of Shabtai et al. '272 under 35 USC §103(a).

The references used to reject the main claim 1 have been discussed above.

Shabtai '272 disclose a process for converting lignin into reformulated, partially oxygenated gasoline by:

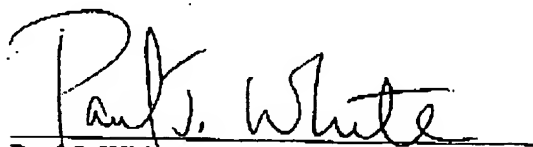
- (a) providing a lignin material;
- (b) subjecting the lignin material to a base-catalyzed depolymerization reaction in the presence of a supercritical alcohol, followed by a selective hydrocracking reaction in the presence of a superacid catalyst to produce a high oxygen-content depolymerized lignin product; and
- (c) subjecting the depolymerized lignin product to an etherification reaction to produce a reformulated, partially oxygenated/etherified gasoline product.

While Shabtai et al. '272 may use a super based catalyst with methanol, ethanol, or a alcohol-water mixture to affect base-catalyzed depolymerization, Shabtai '272 does not suggest or teach the use of water per se with the base to cause base-catalyzed depolymerization of lignin.

Further, there is no teaching in Shabtai et al. '272 equating the use of a base catalyzed depolymerization using an alcohol-water mixture or alcohol alone to the use of water alone (let alone low concentrations of base in water to effect depolymerization of lignin.

Accordingly, even if the depolymerization taught by Shabtai '272 were substituted for or combined with the references used to reject the main claim 1, applicants' application would not result, for the reason that, applicants use of a dilute aqueous base solution as an efficient reaction medium for base-catalyzed depolymerization of lignin using a 2-5 weight percent alkali solution results in a 73-74.5 weight percent conversion to ether-solubles - whereas the use of alkali in a supercritical alcohol reaction medium requires about 10 weight percent or more alkali to effect similar lignin conversion, as indicated in applicants' specification at page 10, lines 6-25.

In view of the foregoing amendments, remarks, and arguments, it is believed that the application is now in condition for allowance and early notification of the same is earnestly solicited.



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